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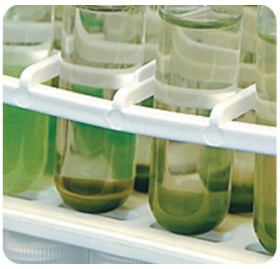
Metrics and Key Outcomes Related to SFAz Grant Programs





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Key Metrics for SFAz Grants

Summary Findings

Based on Battelle's survey of Science Foundation Arizona (SFAz) grantees across all of its programs from 2007 through 2010 state funding, SFAz's performance-based, competitive grant programs in R&D partnerships, technology commercialization and science, technology, engineering and math (STEM) talent advancement are demonstrating a growing record of success and tangible economic benefits:

- **Leverage in R&D funding from SFAz grants is rising and having broader economic and significant job impacts for Arizona over the first four years of funding**: Among the combined $77.6 million in state funding to SFAz from 2007 through 2009, $63.4 million has been invested in university and nonprofit research funding initiatives which resulted in an additional $199.5 million in industry match and non-state research funding raised in support of SFAz's grant activities, or an additional $3.15 from non-state sources for every $1.00 in state funding.[1] This amount of leveraged funds is up from last year's cumulative total of $152.8 million and leverage per dollar figure of $3.06. State 21st Century funds have invested in grants generating 1,334 jobs, 849 publications, 117 patents applied for or issued, 10 technology licenses, and 15 companies created.

  In September 2010, the Governor's Office of Economic Recovery (GOER) awarded SFAz $10 million in funding from the American Recovery & Reinvestment Act (ARRA) for specific programs, of which $6.5 million was for research projects including $300,000 to incubate the Aerospace and Defense Initiative. While still in the early stage of work, the GOER investment has already produced 121 jobs, leveraged $2.6 million in additional research funding, and generated 2 scientific publications.

  The additional $199.5 million in industry match and non-state research funding represents new wealth brought into Arizona by SFAz's research activities, and has economic multiplier impacts on Arizona's economy. These broader economic impacts occur because of the successive cycles of spending, earning,

SFAz Programs Continue to Expand Direct Cumulative Impacts:

SFAz continues to make strong progress and generate significant impacts. Over the past year, SFAz grant programs have shown significant gains across a range of key outcomes. Over the year, SFAz grant programs have:

- Increased total funds leveraged by industry match or other sources by $46.7M; in turn increased its leverage per dollar awarded by $.09 to $3.15 from non-state sources for every $1 in state funding.
- Increased direct jobs associated with the grants by 373 to 1,524.
- Increased patents filed or issued by 36 to 120.
- Increased technology licenses by 1 to 12.
- Increased scientific publications by 408 to 1,168.
- Increased Graduate Research Fellows by 40 to 263.
- Increased student involvement in STEM education programs (both direct and indirect) with nearly 81,000 impacted this year and 4-year totals exceeding 240,000.
- Increased teacher involvement in STEM education programs (both direct and indirect) by nearly 2,600 to a 4-year total of 5,489.

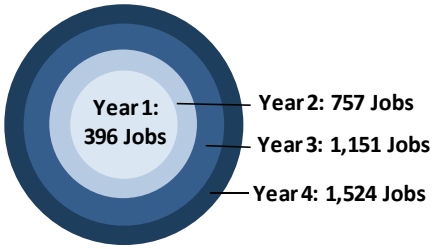
[1] The leverage calculation is based only on those university and nonprofit research funding initiatives that involve an industry match or raising additional funds. These include CAA, SBC, and SRG awards and exclude GRF and STEM Education grants.

and re-spending that add to the economic base of Arizona from the new wealth brought to Arizona from SFAz's leveraged funds. Battelle's analysis in applying an economic input-output model to measure these economic impacts finds an additional $232.5 million is generated due to the multiplier effects.

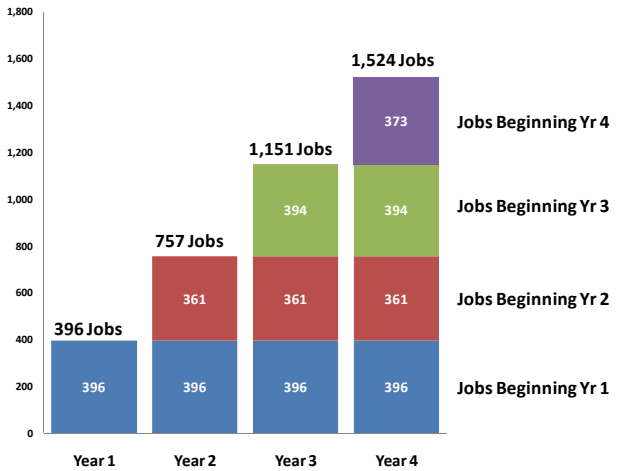
- **SFAz grants and their leveraged funds are supporting a significant number of jobs, with 1,524 current jobs reported by grantees this year**. In addition to these direct jobs, the grant programs and their additional leveraged funding generate multiplier effects throughout the economy and represent an additional 1,973 "job years" over the four-year period.[2]

  When measuring cumulative employment impacts, the value should be interpreted as *job years*. Job years convey a different type of job impact than the number of jobs because they are a measure of job stability. For example, an individual may have been hired in year one of a grant and have the same job in year two. While everyone would consider this one job, from an impact perspective it constitutes two job years.

  Direct jobs associated with the grants have steadily increased to 1,524.



These same direct jobs can be expressed as job years in a cumulative sense with grants adding new jobs each year on top of the existing base. These building impacts and job years are represented in the bar chart below. The four-year cumulative job impacts sum to 3,828 direct job years from 2007 through 2010.



The 1,973 indirect and induced job year impacts are on top of the 3,828 direct job years resulting from SFAz's overall grant activities identified from Battelle's survey of SFAz grant programs…so, in total, an estimated 5,801 job years result from just the research activities associated with SFAz's grant funding over the 2007 to 2010 period.

[2] For more detailed information on the approach to economic impact modeling for SFAz see the "Economic Impact Modeling" section that follows in this report.

Over the longer term, SFAz's programs that spur public-private research and development partnerships and technology commercialization throughout the State of Arizona will have even greater economic impacts through the private sector jobs created based upon new products developed and new start-up companies launched in Arizona.

- **SFAz grants are fueling innovation and discovery in Arizona**. The key measures to track whether SFAz's grant activities are well positioned to fuel future economic impacts for Arizona include publications of research results in peer-reviewed journals, patenting of intellectual property, licensing of intellectual property to industry and the formation of new technology businesses. In each of these measures, SFAz is demonstrating a growing innovation pipeline in only four years. As of June 2011, the cumulative impact of SFAz's grant activities has generated 1,168 publications, 120 patents filed and/or issued, 12 technology licenses in place, and 16 technology company formations in Arizona. Most metrics have seen significant increases, even from last year, when SFAz's cumulative grant activities were at 760 publications, 84 patents filed and issued, 11 technology licenses in place, and 16 technology companies formed in Arizona.

  It is not just the cumulative totals in measures of innovation that make SFAz stand out, but its greater productivity in translating research funding into innovation. SFAz's research and development grants—with its focus on advancing university-industry partnerships and commercialization—perform well relative to the technology development activities typically found across the university research enterprise in Arizona with two of three key technology transfer metrics outperforming the university-wide averages.

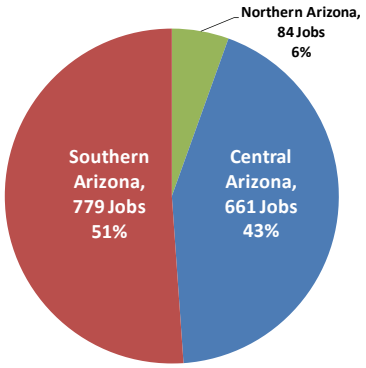
  SFAz-supported projects generate:

  - One patent applied for or issued for every $2.1 million in total university research funding generated over the past four years, well ahead of the four-year Arizona university-wide average of one patent per $3.9 million in funding.
  - One license for every $20.6 million in total university research funding generated over the past four years, behind the four-year Arizona university-wide average of one license per $12.4 million. Licensed technologies are products or processes sold for commercial use.
  - One new company start-up for every $15.4 million in total university research funding generated over the past four years, well ahead of the four-year Arizona university-wide average of one start-up per $92.7 million.
- **SFAz STEM education initiatives are growing the next generation of talent in Arizona.** Over their early four-year existence, STEM education activities have impacted more than 240,000 students and 5,489 teachers at the K-12 and community college level either through direct or indirect participation. A survey of program quality ratings from both teachers and students conducted this year were very positive, with average ratings of 2.8 for teachers and 2.8 for students out of a scale of 1 to 3, with 3 being the highest or "outstanding" rating. Several STEM initiatives require local matching funds and have received $5.5 million in additional match since their inception.

  SFAz also is advancing the growth in top talent across STEM fields with support for 263 graduate fellowships for PhD students in STEM fields, for which research universities in Arizona have contributed another $15.5 million in university funds and tuition scholarships.
- **SFAz's R&D grant activities have statewide impacts**. SFAz works with research universities and non-profit research and development organizations across the state—and the impacts of SFAz's grant activities in terms of leveraged funds raised, direct jobs created, and innovation measures occurs across Central, Northern and Southern Arizona.
  - In direct jobs resulting from SFAz funded research grants, 661 were located in Central Arizona, 84 in Northern Arizona and 779 in Southern Arizona.

- The leveraged funding from industry match and non-state research funding sources also were widely distributed with $64.4 million in Central Arizona, $6.0 million in Northern Arizona and $89.3 million in Southern Arizona. This is equivalent to additional indirect and induced job-year impacts from the economic multipliers associated with the leveraged funding raised of 856 job years for Central Arizona, 109 for Northern Arizona and 1,008 for Southern Arizona.

Current Direct Employment by Primary Region Served



- Innovation measures, particularly from patents, licenses and new company formations resulting from SFAz grants are concentrated more in and around Central and Southern Arizona, reflecting their role in the majority of grants, although in research publications all three regions report significant totals.

Summary Highlights by SFAz Grant Programs

University and Nonprofit Research Funding Initiatives

Background: SFAz supports three major research funding initiatives, including:

- **Strategic Research Group (SRG)** grants, which seed strategic collaborations between Arizona's nonprofit research-performing institutions and industry partners in order to create economic advantages for the state.[3] There have been 13 2007 SRG grants, 6 2008 grants, 6 2009 grants, and 4 2010 grants for a 4-year total of 29 SRG grants.
- **Small Business Catalytic (SBC)** grants, which invest in technologies being developed at Arizona's research-performing institutions to allow a researcher to begin to move a concept toward company creation up to the point where federal research grants or venture capital funding can support the project. There have been 14 total SBC grants, with 8 in 2007 and 6 in 2008.[4]
- **Competitive Advantage Awards (CAA)**, which funds projects that offer sound potential to secure significant federal grants with strategic focus in three primary areas—sustainable systems, information communication technologies, and the biosciences. There have been 57 total CAA grants awarded with 26 in 2007 and 31 in 2008.

Key metrics for the university and nonprofit research funding initiatives span the continuum from discoveries to commercialization, and include scientific publications, patents filed and issued, technology licenses, companies created, jobs created from the research activity, dollars leveraged from other sources, industry match and talent development.

[3] As a 501(c)(3) nonprofit, Science Foundation Arizona may only provide funding to public universities and other nonprofit organizations for scientific, medical and engineering research and education.
[4] With the reduction in funding in 2009 and 2010, no grants were awarded under the SBC and CAA programs.

Key Findings:

- SFAz cumulative grant funding for university and nonprofit research funding initiatives has totaled $63.4 million from 2007 through 2010 with an additional $6.2 million funded by GOER/ARRA. Grant recipients have used this to leverage an additional $199.5 million in total matching funds—$42.4 million in industry match from the SRG program and $157.1 million in other sources beyond the original funding. In addition, the GOER/ARRA funded 2010 SRG grants have raised $6.2 million in industry match and $2.6 million from other sources. Additional dollars come through a variety of sources including federal, foundation, venture capital, or additional university or industry funding beyond the original match.
- For every $1 funded by SFAz in university and nonprofit research funding initiatives, $3.15 has been leveraged from other sources.
    - The SRG ($86.9 million from non-ARRA funded grants) and CAA ($46.8 million) programs have brought in the vast majority of the $157.1 million in cumulative funds leveraged from other sources, accounting for 55% and 30% of funds, respectively. This is due to the structure of each program as the SRG has a match requirement and the CAA was designed as bridge grants with the expectation of leveraging funds.
- Among the SFAz grants focused on university research, the cumulative, 4-year total number of scientific publications has reached 888. About half (466 publications) of these publications were related to research conducted under the CAA program which is not surprising given its strong focus on fundamental research.[5]
- SFAz grant recipients have generated strong patent activity, with 95 patents filed in just a 4-year period. Given the young nature of these grant programs, just 22 patents have been issued thus far, although in just the last year the number of patents issued has increased from just 8 to 22. Participants in each of the three major programs have had substantial numbers of patent applications with the SBC leading the way in both applications and patents issued reflecting the programs' focus on technology commercialization from Arizona's research-performing institutions.
- A total of 12 technology licenses have been issued across SRG-SBC-CAA programs. The SBC program has been responsible for 7 of these 12 technology licenses to date.
- Since these programs began, a total of 16 companies have been created, primarily out of the SRG and SBC grant programs. SRG grants have led to the formation of 8 companies. The SBC, which has generated 5 companies to date, is specifically designed to act as a "catalyst" for company development with seed funds targeted at research with high-impact commercial potential. The remaining 3 companies were formed under the CAA program.
- University and nonprofit research funding initiatives and partnerships supported by SFAz have combined to create 1,490 jobs including jobs related directly to SFAz funding to non-profit research performing institutions and additional jobs funded by industry.
- A further benefit of the SFAz grants is developing young research talent within Arizona's universities. The SRG, SBC, and CAA programs combine to employ 623 student researchers including undergraduates, graduate students, and post-doctoral researchers. Graduate students make up 45% of these student jobs.

[5] The data presented here for University and Nonprofit Research Initiatives will not match totals presented in the previous section as those totals include metrics/outcomes associated with grants funded under the Stardust Director's Fund (SDF) and even the GRF that had impacts included in those totals including: publications (SDF had 4; GRF had 276); patent applications (SDF had 3); and total jobs (SDF had 34).

Graduate Research Fellowships

Background: Graduate Research Fellowships (GRF) are designed by SFAz to recruit the best and brightest graduate-level students in science, math and engineering from Arizona and beyond. The Fellowships were designed to create a "culture of research, excellence, and innovation" and plant the seed that Arizona is competitive with the nation's best universities. This effort can transform Arizona's competent graduate programs into world-competitive programs while developing a work force pipeline to meet the needs of Arizona's technology-related employers.

Annual metrics reports for the GRF program will focus on key outcomes related to post-doctoral research and placement of PhD fellows in industry and academic positions once they graduate. Given the GRF program is relatively new (only in place for four years), the three participating universities report that just one of the Fellows has received their Doctorate degree. Therefore, outcomes and metrics reported here are limited to total Fellows and their cumulative output of scientific publications. However, it is important to recognize the pathway to a PhD for most includes receipt of a Master's degree at an intermediate stage. Roughly half of the current Fellows have received a Master's degree, including a number of MS degrees in engineering. Notably, the GRF program benefits K-12 education in Arizona as Fellows participate in STEM activities in elementary, middle and high schools throughout the state.

Key Findings:

- Since its inception in 2007, SFAz has funded 263 Graduate Research Fellowships in science, technology, engineering and math (STEM) fields at Arizona's three major universities—the University of Arizona (124 fellows), Arizona State University (116 fellows), and Northern Arizona University (23 fellows).
- The 263 graduate students supported through the GRF program have generated a cumulative total of 276 scientific research publications as either an author or co-author.
- Although the GRF program does not require or leverage industry dollars, it has consistently leveraged significant tuition credits and waivers through agreements with the three participating State universities. Battelle has estimated that for the $18.2 million awarded by SFAz to Fellows from 2007 through 2010, $15.5 million in university funds have been leveraged. This represents $0.85 in additional funds leveraged for each $1.00 awarded by SFAz.

STEM Education Programs

Background: SFAz supports programs that improve math and science instruction and learning. Last year, the programs were expanded to include community college students and teachers. These grants include engaging motivated math and science teachers in paid laboratory research internships to update their knowledge and bring it back to the classroom. Also, these grants seek to broaden the participation of K-12/community college students—particularly those from rural and underserved communities—in scientific discovery activities with researchers and engineers.

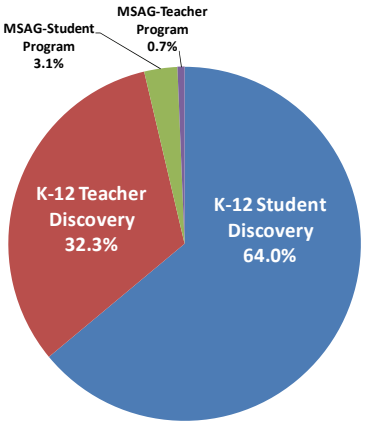
To augment these programs, SFAz launched the STEM Initiative (Science, Technology, Engineering, and Math) in 2008 with private funds to build the high-skilled foundation for Arizona's 21st Century knowledge-based economy.

Currently, there are 21 active grants focused on STEM education programs.

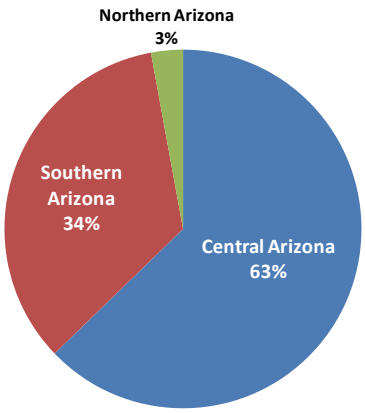
Key Findings:

- For the current school year ending June 2011, across all SFAz STEM education programs there were 80,903 student and 2,589 teacher participants involved either directly or indirectly. This brings the cumulative number of students involved during the four-year period to 240,591 and the cumulative number of teachers involved to 5,489.
- For the current year, the types of students served has strongly emphasized diversity, with 79.6% considered low income, 27.1% coming from rural areas, and 5.0% Native American.
- Program quality ratings by teachers in the Teacher Discovery Program were very positive with an average quality rating of 2.9 out of 3, and 87% judging the programs to be "outstanding." Just 2% of teachers indicated that the programs need improvement, out of the 185 teachers responding to the SFAz survey administered by grantees.
- Similarly, students participating in the Student Discovery Program also rated the programs highly, with an average quality rating of 2.8 out of 3, and 84% finding the programs "outstanding." Just 2% of students indicated that the programs need improvement, out of 4,551 students responding to the survey.
- Students taking SFAz-sponsored Discovery programs overwhelmingly expressed an interest in pursuing more advanced science and math courses, with 91% indicating more interest in taking advanced math and science since participating in the SFAz program out of 4,157 responding to that question in the survey.
- In addition to the more established SFAz Discovery programs, relatively new "Mathematics and Science Achievement" (MSAG) Student and Teacher programs are finishing their second academic year. Early outcomes from these new programs are already demonstrating an impact with the Student programs reaching 2,468 students this school year with a generally positive overall rating by students (2.7 out of 3).
- Expanding this year, with funding from GOER and ARRA, Engineering Pathways, a rural student-focused program designed to create student interest and enthusiasm for STEM careers, better prepare students in math and science, and offer early college, industry-driven learning experiences that result in certifications and two- and four-year degrees in STEM fields.

Students Participating in SFAz STEM Programs, 2010-11 Academic Year by Program Type



Students Participating in SFAz STEM Programs, 2010-11 Academic Year by Primary Region Served



Metrics

University Research Funding Initiatives

Methodology

The Battelle Technology Partnership Practice was retained to collect key metrics associated with, and outcomes related to Science Foundation Arizona's (SFAz) grant programs including Competitive Advantage Awards (CAA), Strategic Research Groups (SRG), Small Business Catalytic (SBC), and Strategic Initiatives (SI). SFAz grants require recipients to maintain comprehensive records related to quantitative outcomes of each research grant, this information was collected directly from the Principal Investigator (PI) for each grant via an online survey collection.

Key metrics and their definition in this context include:

- **Scientific Publications**, published or co-published by grantees since the start of the grant related to its research (included are peer-reviewed papers for journals and juried abstracts for conferences that have been accepted or published). If a publication was co-authored by more than one grantee it was counted only once.
- **Patents.** PIs were required to record both the total number of patents applied for, including those provisionally granted in addition to the total number of patents issued. Patents were reported based on current status only, i.e. one record per patent.
- **Technology Licenses.** PIs were required to record the number of technology licenses issued since the grant began. In this context, a Technology License includes any technology transferred for which the PI is receiving some type of compensation, whether royalty, equity, one-time payment or other arrangement.
- **Companies Created.** Certain SFAz programs are focused on the creation of new companies, especially the focus of the SBC program. In this context, PIs were asked to include only those "active" companies that are operational with at least one paid employee.
- **Jobs.** PIs were required to record the number of jobs created that were specifically associated with their SFAz grant. Individuals hired or working, regardless of the level of effort or considerations of hours, were counted as one job.
- **Funds Leveraged**. Above and beyond the industry match required for SRG grants, PIs were required to record the cumulative value of all dollars leveraged from all sources that fund research specific to this grant beyond the original amounts invested by SFAz or through industry matching funds. These funds only include dollars actually awarded (not pending) and were reported by funding source.
- **Industry Match.** This corresponds to the industry match in 21st Century grants verified by the Arizona Commerce Authority at the outset.
- **Talent Development.** This corresponds to the total number of undergraduates, graduate students and post-docs employed in SFAz funded grants.

In total, 106 individual grants were included in the metrics collection for the CAA, SRG, SBC, SI, and SDF programs, among these nearly all PIs participated and provided grant-related data (95%).

University Research Funding Initiatives: CAA, SBC, SRG, and SI Programs

Program Area	Scientific Publications													
	2007 Grants					2008 Grants				2009 Grants			2010 Grants	All Grants 2007–10
	Yr. 1	Yr. 2	Yr. 3	Yr. 4	Total 2007 Grants	Yr. 1	Yr. 2	Yr. 3	Total 2008 Grants	Yr. 1	Yr. 2	Total 2009 Grants	Yr. 1	2007–10
CAA	32	90	24	64	**210**	84	63	109	**256**	–	–	–	–	**466**
SBC	17	–	11	3	**31**	5	6	4	**15**	–	–	–	–	**46**
SRG	9	47	24	28	**108**	8	132	77	**217**	14	35	**49**	**2**	**376**
SDF/SI	–	–	2	–	**2**	–	1	–	**1**	–	–	–	**1**	**4**
Total, All Programs	**58**	**137**	**61**	**95**	**351**	**97**	**202**	**190**	**489**	**14**	**35**	**49**	**3**	**892**

Program Area	Patent Applications Filed													
	2007 Grants					2008 Grants				2009 Grants			2010 Grants	All Grants 2007–10
	Yr. 1	Yr. 2	Yr. 3	Yr. 4	Total 2007 Grants	Yr. 1	Yr. 2	Yr. 3	Total 2008 Grants	Yr. 1	Yr. 2	Total 2009 Grants	Yr. 1	2007–10
CAA	–	3	3	5	**11**	5	4	9	**18**	–	–	–	–	**29**
SBC	12	6	–	6	**24**	6	4	–	**10**	–	–	–	–	**34**
SRG	8	–	9	–	**17**	6	5	2	**13**	2	–	**2**	–	**32**
SDF/SI	–	1	2	–	**3**	–	–	–	–	–	–	–	–	**3**
Total, All Programs	**20**	**10**	**14**	**11**	**55**	**17**	**13**	**11**	**41**	**2**	–	**2**	–	**98**

University Research Funding Initiatives: CAA, SBC, SRG, and SI Programs (continued)

Program Area	Patents Issued													
	2007 Grants					2008 Grants				2009 Grants			2010 Grants	All Grants 2007–10
	Yr. 1	Yr. 2	Yr. 3	Yr. 4	Total 2007 Grants	Yr. 1	Yr. 2	Yr. 3	Total 2008 Grants	Yr. 1	Yr. 2	Total 2009 Grants	Yr. 1	2007–10
CAA	–	–	1	1	2	1	–	–	1	–	–	–	–	3
SBC	–	1	3	7	11	–	–	2	2	–	–	–	–	13
SRG	–	–	1	5	6	–	–	–	–	–	–	–	–	6
SDF/SI	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total, All Programs	–	1	5	13	19	1	–	2	3	–	–	–	–	22

Program Area	Technologies Licensed													
	2007 Grants					2008 Grants				2009 Grants			2010 Grants	All Grants 2007–10
	Yr. 1	Yr. 2	Yr. 3	Yr. 4	Total 2007 Grants	Yr. 1	Yr. 2	Yr. 3	Total 2008 Grants	Yr. 1	Yr. 2	Total 2009 Grants	Yr. 1	2007-10
CAA	–	1	–	–	1	–	–	1	1	–	–	–	–	2
SBC	3	2	–	–	5	2	–	–	2	–	–	–	–	7
SRG	–	1	1	–	2	–	1	–	1	–	–	–	–	3
SDF/SI	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total, All Programs	3	4	1	–	8	2	1	1	4	–	–	–	–	12

University Research Funding Initiatives: CAA, SBC, SRG, and SI Programs (continued)

Program Area	Companies Created												
	2007 Grants				2008 Grants				2009 Grants			2010 Grants	All Grants 2007–10
	Yrs. 1 & 2	Yr. 3	Yr. 4	Total 2007 Grants	Yr. 1	Yr. 2	Yr. 3	Total 2008 Grants	Yr. 1	Yr. 2	Total 2009 Grants	Yr. 1	2007–10
CAA	1	–	–	**1**	–	1	1	**2**	–	–	–	–	**3**
SBC	1	–	–	**1**	3	–	1	**4**	–	–	–	–	**5**
SRG	4	1	–	**5**	–	2	–	**2**	1	–	**1**	–	**8**
SDF/SI	–	–	–	–	–	–	–	–	–	–	–	–	–
Total, All Programs	**6**	**1**	**–**	**7**	**3**	**3**	**2**	**8**	**1**	**–**	**1**	**–**	**16**

Program Area	Jobs Created				
	Total 2007 Grants	Total 2008 Grants	Total 2009 Grants	Total 2010 Grants	All Grants 2007–10
CAA	199	217	–	–	**416**
SBC	52	40	–	–	**92**
SRG	322	393	146	121	**982**
SDF/SI	24	–	–	10	**34**
Total, All Programs	**597**	**650**	**146**	**131**	**1,524**

University Research Funding Initiatives: CAA, SBC, SRG, and SI Programs (continued)

Program Area	Dollars Leveraged from Other Sources													
	2007 Grants					2008 Grants				2009 Grants			2010 Grants	All Grants 2007–10
	Yr. 1	Yr. 2	Yr. 3	Yr. 4	Total 2007 Grants	Yr. 1	Yr. 2	Yr. 3	Total 2008 Grants	Yr. 1	Yr. 2	Total 2009 Grants	Yr. 1	2007–10
CAA	$13.9M	$0.9M	$7.7M	$2.1M	**$24.6M**	$10.9M	$9.1M	$2.2M	**$22.2M**	–	–	–	–	**$46.8M**
SBC	$5.8M	$2.7M	$3.9M	$4.5M	**$16.9M**	$1.0M	$0.7M	$3.2M	**$4.9M**	–	–	–	–	**$21.8M**
SRG	$11.3M	$7.7M	$16.9M	$18.9M	**$54.8M**	$4.1M	$6.2M	$9.5M	**$19.8M**	$6.4M	$5.9M	**$12.3M**	**$2.6M**	**$89.5M**
SDF/SI	$1.0M	$0.2M	–	–	**$1.2M**	–	–	–	–	–	–	–	**$0.4M**	**$1.6M**
Total, All Programs	**$32.0M**	**$11.5M**	**$28.5M**	**$25.5M**	**$97.5M**	**$16.0M**	**$16.0M**	**$14.9M**	**$46.9M**	**$6.4M**	**$5.9M**	**$12.3M**	**$3.0M**	**$159.7M**

Program Area	Industry Match				
	2007 Grants	2008 Grants	2009 Grants	2010 Grants*	All Grants, 2007–10
SRG	**$22.5M**	**$15.3M**	**$4.6M**	**$6.2M**	**$48.6M**

University Research Funding Initiatives: CAA, SBC, SRG, and SI Programs (continued)

Program Area	Talent Development: Employment of Post-Secondary Students & Post-Doctoral Researchers													
	2007 Grants					2008 Grants				2009 Grants			2010 Grants	All Grants 2007–10
	Yr. 1	Yr. 2	Yr. 3	Yr. 4	Total 2007 Grants	Yr. 1	Yr. 2	Yr. 3	Total 2008 Grants	Yr. 1	Yr. 2	Total 2009 Grants	Yr. 1	2007–10
CAA	N/A	N/A	29	74	**103**	65	55	12	**132**	–	–	–	–	**235**
SBC	N/A	N/A	9	17	**26**	10	–	12	**22**	–	–	–	–	**48**
SRG	N/A	N/A	57	70	**127**	29	28	52	**109**	37	35	**72**	**32**	**340**
SDF/SI	N/A	N/A	2	3	**5**	–	–	–	–	–	–	–	–	**5**
Total, All Programs	**N/A**	**N/A**	**97**	**164**	**261**	**104**	**83**	**76**	**263**	**37**	**35**	**72**	**32**	**628**

N/A = data not available for individual year.

Graduate Research Fellowships

Methodology

Battelle developed a survey sent to a representative from each of the three universities with Graduate Research Fellows (University of Arizona, Arizona State University, and Northern Arizona University) to capture the required annual metrics data. In its early stages, the universities report that just one of the GRF's has received their doctorate degree and therefore, at this time, the metrics include only limited post-doctoral outcomes for these students. The metrics include scientific publications defined as follows.

- **Scientific Publications**, published or co-published by grantees since the start of the grant related to its research (included are peer-reviewed papers for journals and juried abstracts for conferences that have been accepted or published). If a publication was co-authored by more than one grantee it was counted only once.

Graduate Research Fellowships

Graduate Research Fellowships	Total Fellows	Scientific Publications	Doctorates Awarded	Post-Doctoral Studies/Positions		
				Fellowships Awarded	At Top 25% of Institutions/Labs	Working in Arizona
Total GRF	**263**	**276**	**1**	**0**	**0**	**0**
Univ. of Arizona	124	128	–	–	–	–
Arizona State Univ.	116	113	1	–	–	–
Northern Arizona Univ.	23	35	–	–	–	–

Note: Publications data were not collected by funding year.

STEM Education Programs

Methodology

Battelle developed a survey to each of the STEM Education grantees to capture the required annual metrics data including:

- Numbers of teacher and student participants
- The diversity of students participating in the programs or enrolled in classes of the teachers participating in professional development programs, tracking low income students, rural students and Native American students
- Program quality ratings by both teacher and student participants
- Retention of math and science teachers participating in the programs
- Interest of students in pursuing advanced courses in science and math in high school

To collect many of these measures required the STEM Education grantees to administer surveys to participating teachers and students. While grantees made active efforts to get responses from participating teachers and students, similar to all surveys not all student and teacher participants responded. Of the 21 active grants (several of which are just getting started), surveys were at least partially completed by all grantees.

Teacher Discovery

	Teachers Enrolled	Students of Teachers Enrolled				Teacher Quality Rating (out of 3 point scale)*	Teacher Retention*
		Total Students Enrolled in Classes of Teachers	Percent Low Income Students	Percent Rural Students	Percent Native American Students		
Current	329	26,135	37.6%	24.8%	10.2%	2.85 with 87% Outstanding	92%
Cumulative, 2007–10	1,143	120,966	42.3%	25.4%	7.1%	2.85	93%

* 185 teachers responded.

Student Discovery

	Teachers of Participating Students	Students Enrolled				Student Quality Rating (out of 3 point scale)*	Interest in Pursuing Advanced Science & Math**
		Total	Percent Low Income Students	Percent Rural Students	Percent Native American Students		
Current	2,060	51,772	92.8%	27.0%	2.8%	2.81 with 84% Outstanding	91%
Cumulative, 2007–10	3,983	114,116	82.1%	32.3%	4.7%	2.77	89%

*Out of 4,551 student responses; **Out of 4,157 student responses.

Mathematics and Science Achievement (MSAG) – Student Program

	Teachers of Participating Students	Students Enrolled				Student Quality Rating (out of 3 point scale)*	Interest in Pursuing Advanced Science & Math*
		Total	Percent Low Income Students	Percent Rural Students	Percent Native American Students		
Current	176	2,468	61.3%	33.5%	11.0%	2.70	67%
Cumulative, 2009–10	324	4,697	66.6%	22.2%	13.2%	2.54	66%

*Out of 573 student responses.

Mathematics and Science Achievement (MSAG) – Teacher Program

	Teachers Participating	Students of Teachers Enrolled				Teacher Quality Rating (out of 3 point scale)*	Teacher Retention*
		Total	Percent Low Income Students	Percent Rural Students	Percent Native American Students		
Current	24	528	83.3%	76.1%	35.8%	2.80	90%
Cumulative, 2009–10	39	812	89.2%	84.5%	35.8%	2.82	88%

*Out of 20 teacher responses.

Consolidated Tracking of Students and Teachers in all STEM Education Programs

	Teachers Enrolled and those of Participating Students	Students Enrolled and those of Participating Teachers			
		Total	Percent Low Income Students	Percent Rural Students	Percent Native American Students
Current Year	2,589	80,903	79.6%	27.1%	5.0%
Cumulative, 2007–10	5,489	240,591	65.9%	29.6%	6.0%

Metrics Beyond Program Classification: Return on Investments by Funding Source

SFAz funds its programs through several sources. This section takes an alternative approach to examining the same program metrics and outcomes presented above, though here through the lens of funding source as opposed to simply by program area only. Funding sources often cross-cut individual programs, for instance, the CAA grants are funded through the 21st Century Fund and through Private Match/Bisgrove funds. Similarly, some individual grants have been supported through multiple funding sources, particularly in recent years.

Presenting outcomes by funding source allows for a direct perspective on returns on investment.

Funding Sources: University Research Funding Initiatives

University Research Funding Initiatives: Metrics by Grant Funding Source, 2007–2010

Programs & Funding Sources*	Grant Funding Totals (2007–10)	Scientific Publications	Patent Applications	Patents issued	Technology Licenses	Companies Created	Jobs	Funds Leveraged from Other Sources
21st Century Fund, Total	**$61,570,535**	**849**	**95**	**22**	**10**	**15**	**1,334**	**$153,093,005**
CAA	$7,591,054	429	29	3	2	3	381	$44,398,138
SBC	$5,467,606	46	34	13	5	4	92	$21,792,012
SRG	$48,511,875	374	32	6	3	8	861	$86,902,855
Governor's Office of Economic Recovery/ARRA Fund (SRG Grants), Total	**$6,200,000**	**2**	**-**	**-**	**-**	**-**	**121**	**$2,608,428**
Private-match, Bisgrove, Total	**$1,205,560**	**38**	**-**	**-**	**-**	**-**	**35**	**$2,388,217**
CAA	$935,560	37	-	-	-	-	35	$2,388,217
SDF	$150,000	1	-	-	-	-	-	-
SI	$120,000	-	-	-	-	-	-	-
Stardust Director's Fund, Total	**$528,566**	**2**	**3**	**-**	**-**	**-**	**33**	**$1,224,000**
Virginia G. Piper Charitable Trust (SI Grants), Total	**$62,179**	**1**	**-**	**-**	**-**	**-**	**1**	**$400,000**
Total, All University Research Funding Initiatives	**$69,566,840**	**892**	**98**	**22**	**10**	**15**	**1,524**	**$159,713,650**

Note: Matching funds from industry help to support the 21st Century Funds with respect to the outcomes of the SRG program.

*Note: Grants are classified here by their original/primary funding source though many have received funding from multiple sources, for example, while many grants were initially funded through the 21st Century fund, private matching funds (Bisgrove and ACF/Harrington) have allowed grantees to continue the work and funds from the Federal ARRA legislation directed through the Arizona Governor's Office of Economic Recovery have been used to support new grants.

Funding Sources: Graduate Research Fellowships

Graduate Research Fellowships: Grant Funding Source, 2007–2010

Funding Sources	Grant Funding Totals (2007–10)	Graduate Research Fellows Supported	Scientific Publications
21st Century Fund	$12,815,044	N/A	N/A
Private Match, Bisgrove	$3,800,000	N/A	N/A
Governor's Office for Economic Recovery/ARRA Fund	$1,600,000	N/A	N/A
Total, All GRF	**$18,215,044**	**263**	**276**

Funding Sources: STEM Education Initiatives

STEM Education Initiatives: 2010 Metrics by Grant Funding Source, 2007–2010

Programs & Funding Sources	Grant Funding Totals (2007–10)	Teachers Enrolled and those of Participating Students 2010	a. Students Enrolled & those of Participating Teachers 2010				Student Quality Rating (out of 3 point scale)	Teacher Quality Rating (out of 3 point scale)
			Total	Percent Low Income	Percent Rural	Percent Native American		
K-12 Teacher & Student Discovery*	**$14,542,449**	**2,389**	**77,907**	**80.3%**	**26.5%**	**4.5%**	**2.77**	**2.85**
21st Century Fund	$10,365,126	2,389	77,907	80.3%	26.5%	4.5%	2.77	2.85
Private Match, Bisgrove	$4,077,322	-	-	-	-	-	-	-
AZ Community Foundation	$100,000	-	-	-	-	-	-	-
MSAG, STEM Board of Education Fund	**$2,400,000**	**200**	**2,996**	**65.2%**	**41.0%**	**15.4%**	**2.54**	**2.82**
Engineering Pathways, GOER/ARRA Fund**	**$1,325,325**	-	-	-	-	-	-	-
Total, All STEM Education Initiatives	**$18,267,774**	**2,589**	**80,903**	**79.6%**	**27.1%**	**5.0%**	**N/A**	**N/A**

Note: MSAG = Math and Science Achievement Grant; GOER = Governor's Office of Economic Recovery.

*Note: All K-12 Teacher & Student Discovery metrics are allocated to the 21st Century Fund as this is the original/primary funding source associated with these grants; however, several grants have received additional significant multi-source funding from both the Private Match (Bisgrove) funds and the ACF fund.

**Note: Engineering Pathways grants funded through the GOER/ARRA have begun and students are enrolling for the fall semester.

Regional Impacts

While SFAz grant activities are focused broadly on targeted partnerships and technology commercialization statewide, each tends to have a more primary focus and set of impacts in the region in which the Principal Investigator (PI) and/or institution is located. By assigning one of three major Arizona regions—Central, Northern, or Southern—to each grant based on location, SFAz can relate impacts and benefits derived from grants more specifically to a local region within Arizona. The tables below highlight metrics and outcomes by type of program and region and reveal the following:

- Grants based primarily in Southern Arizona have had the most success in generating total jobs (779 to date) and companies (9), and raising additional funds ($89.3 million). The University of Arizona hosts the most Graduate Research Fellows with 124 in Southern Arizona. SFAz STEM education initiatives have a strong footprint in Southern Arizona with 371 teachers and more than 27,000 students engaged either directly or indirectly in these programs during 2010.
- Grants to Central Arizona institutions and PIs have generated a leading number of scientific publications (502 to date) and key intellectual property activities with 68 patent applications and 16 patents issued. Central Arizona has 116 Graduate Research Fellows attending Arizona State University. The region has seen the greatest impacts in terms of teachers and students involved either directly or indirectly in STEM education programs sponsored by SFAz during this year with 2,157 teachers and more than 51,000 students.
- Despite the relatively smaller size of Northern Arizona University as an institution and fewer grants than the other regions, Northern Arizona has generated 61 scientific publications, 84 total jobs, and $6.0 million in additional funds leveraged. Twenty three Graduate Research Fellows are conducting their research and graduate studies at Northern Arizona University. In STEM education programs, 61 teachers and 2,299 students in the region participated either directly or indirectly in this most recent academic year.

University and Nonprofit Research Funding Initiatives: Metrics by Program and Region, 2007–2010

SFAz Program	Central Arizona	Northern Arizona	Southern Arizona	Program Total
Scientific Publications				
Competitive Advantage Awards (CAA)	303	61	102	466
Small Business Catalytic (SBC)	27	0	19	46
Strategic Research Groups (SRG)	170	0	206	376
Stardust Director's Fund (SDF)	1	0	2	3
Strategic Initiatives (SI)	1	0	0	1
Scientific Publications, Total	**502**	**61**	**329**	**892**
Patent Applications				
Competitive Advantage Awards (CAA)	25	1	3	29
Small Business Catalytic (SBC)	20	0	14	34
Strategic Research Groups (SRG)	23	0	9	32
Stardust Director's Fund (SDF)	0	0	3	3
Strategic Initiatives (SI)	0	0	0	0
Patent Applications, Total	**68**	**1**	**29**	**98**
Patents Issued				
Competitive Advantage Awards (CAA)	2	1	0	3
Small Business Catalytic (SBC)	8	0	5	13
Strategic Research Groups (SRG)	6	0	0	6
Stardust Director's Fund (SDF)	0	0	0	0
Strategic Initiatives (SI)	0	0	0	0
Patents Issued, Total	**16**	**1**	**5**	**22**
Technology Licenses				
Competitive Advantage Awards (CAA)	1	0	1	2
Small Business Catalytic (SBC)	4	0	3	7
Strategic Research Groups (SRG)	1	0	2	3
Stardust Director's Fund (SDF)	0	0	0	0
Strategic Initiatives (SI)	0	0	0	0
Technology Licenses, Total	**6**	**0**	**6**	**12**

University and Nonprofit Research Funding Initiatives: Metrics by Program and Region, 2007–2010 (continued)

SFAz Program	Central Arizona	Northern Arizona	Southern Arizona	Program Total
Companies Created				
Competitive Advantage Awards (CAA)	2	0	1	3
Small Business Catalytic (SBC)	3	0	2	5
Strategic Research Groups (SRG)	2	0	6	8
Stardust Director's Fund (SDF)	0	0	0	0
Strategic Initiatives (SI)	0	0	0	0
Companies Created, Total	**7**	**0**	**9**	**16**
Jobs				
Competitive Advantage Awards (CAA)	229	84	103	416
Small Business Catalytic (SBC)	47	0	45	92
Strategic Research Groups (SRG)	375	0	607	982
Stardust Director's Fund (SDF)	9	0	24	33
Strategic Initiatives (SI)	1	0	0	1
Jobs, Total	**661**	**84**	**779**	**1,524**
Funds Raised/Leveraged from Other Sources				
Competitive Advantage Awards (CAA)	$25,016,442	$5,970,808	$15,799,105	$46,786,355
Small Business Catalytic (SBC)	$9,203,000	$0	$12,589,012	$21,792,012
Strategic Research Groups (SRG)	$29,779,113	$0	$59,732,170	$89,511,283
Stardust Director's Fund (SDF)	$0	$0	$1,224,000	$1,224,000
Strategic Initiatives (SI)	$400,000	$0	$0	$400,000
Funds Raised/Leveraged, Total	**$64,398,555**	**$5,970,808**	**$89,344,287**	**$159,713,650**

Graduate Research Fellowships: Metrics by Region, 2007–2010

Metrics	Central Arizona	Northern Arizona	Southern Arizona	Program Total
Total Fellows	**116**	**23**	**124**	**263**
Scientific Publications	113	35	128	**276**
Graduates	1	0	0	**1**

STEM Education Initiatives: Metrics by Region, 2010

SFAz Program	Central Arizona	Northern Arizona	Southern Arizona	Program Total
Teachers Enrolled and those of Participating Students				
Teacher Discovery	29	7	293	329
Student Discovery	1,995	0	65	2,060
MSAG-Student Program	133	30	13	176
MSAG- Teacher Program	0	24	0	24
Total Teachers	**2,157**	**61**	**371**	**2,589**
Students Enrolled and those of Participating Teachers				
Teacher Discovery	2,551	297	23,287	26,135
Student Discovery	47,418	724	3,630	51,772
MSAG-Student Program	1,426	750	292	2,468
MSAG-Teacher Program	0	528	0	528
Total Students	**51,395**	**2,299**	**27,209**	**80,903**

Economic Impact Modeling

A substantial grant-funding organization like SFAz can generate significant positive economic impacts through its targeted investments that most immediately leverage additional funds that result in new wealth for Arizona. Over the longer term, SFAz's programs that spur public-private partnerships and technology commercialization throughout the State of Arizona will have even greater economic impacts through the private sector jobs created.

The estimated economic impacts of the leveraged funding by Science Foundation Arizona were calculated using the Arizona specific input-output models from IMPLAN, one of the most widely used economic impact models in the nation. Input-output analysis is based on the use of multipliers, which describe the response of an economy to a change in demand or production. Multipliers measure the effects on an economy from a source of economic activity—in this case, the leveraged research and development funds from SFAz's grant activities. The economic activity generated is greater than the direct value of the leveraged research and development funds because of the successive cycles of spending, earning, and re-spending. Four measures of the economic impact of the wealth-generating activities of SFAz leveraging additional research and development are considered:

- Direct Effects. The changes in economic activity being analyzed—in this case, the leveraged funding from SFAz's grant activities.
- Indirect Effects. The changes in interindustry purchases, e.g., the purchase of services and goods from Arizona companies from university research and development activities.
- Induced Effects. The changes in spending from households as income and population increase because of changes in production.
- Total Effects. The combined total of direct, indirect, and induced effects.

Given the strong and primary emphasis on university research and development by SFAz, impacts were modeled using the Scientific Research and Development sector in IMPLAN. The leveraged dollar figures represent the cumulative amount over a four-year cycle of grants. The economic impact of SFAz is measured using two economic variables, including:

1. **Output**. The total value of production (sales) in all industries as a result of expenditures by SFAz. This is the number cited in a typical economic impact study.
2. **Employment (expressed in job years)**. The total number of job years created in all industries (including both full- and part-time workers) by the expenditures of SFAz and its ongoing activities and employment base.

Four-Year Economic Impacts of SFAz Industry Matching Funds and Funds Leveraged from Other Sources

Economic Variable	Cumulative Direct Impact	Cumulative Indirect & Induced Impacts	Cumulative Total Impacts
Output, Leveraged Funds	$199.5M	$232.5M	**$432.0M**
Employment (Job Years)	3,828	1,973	**5,801**

Battelle

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Battelle is the world's largest independent research and development organization, providing innovative solutions to the world's most pressing needs through its four global businesses: Laboratory Management, National Security, Energy, Environment and Material Sciences, and Health and Life Sciences. It advances scientific discovery and application by conducting $6.5 billion in global R&D annually through contract research, laboratory management and technology commercialization. Headquartered in Columbus, Ohio, Battelle oversees 22,000 employees in more than 130 cities worldwide, including seven national laboratories that Battelle manages or co-manages for the U.S. Department of Energy and the U.S. Department of Homeland Security, and one international nuclear laboratory in the United Kingdom.

Battelle also is one of the nation's leading charitable trusts focusing on societal and economic impact and actively supporting and promoting science and math education.